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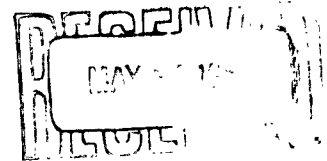
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MEMORANDUM REPORT NO. 1451  
JANUARY 1963

ORDVAC PROGRAMS FOR STAR IDENTIFICATION AND  
COMPUTATION OF STANDARD COORDINATES

A. Roberta Wooten



RDT & E Project No. 1M2229018215  
BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

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ARWooten/bj  
Aberdeen Proving Ground, Md.  
January 1963

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ABSTRACT

Using the camera orientation elements ( $\alpha, \omega, \kappa, c, x_p, y_p$ ) derived from several known stars or determined from instruments, the "Star Identification Program" serves to identify all other photographed stars. After proper identification the "Computation of Standard Coordinates Program" is used to compute the coordinates of the control points for the camera orientation described in BRL Report No. 1065, "A General Solution to the Problem of Photogrammetry" by Hellmut H. Schmid.

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1. STAR IDENTIFICATION

1.1 Flow Chart



1.2 Raster



	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	
00																																	01
02																																	03
04																																	05
06																																	07
08																																	09
0K																																	0S
0N																																	0J
0F																																	0L
10																																	11
12																																	13
14																																	15
16																																	17
18																																	19
1K																																	1S
1N																																	1J
1F																																	1L
20																																	21
22																																	23
24																																	25
26																																	27
28																																	29
2K																																	2S
2N																																	2J
2F																																	2L
30																																	31
32																																	33
34																																	35
36																																	37
38																																	39
3K																																	3S
3N																																	3J
3F																																	3L

	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	
40																																	41
42																																	43
44																																	45
46																																	47
48																																	49
4K																																	4S
4N																																	4J
4F																																	4L
50	SI																																51
52	DI																																53
54	PI																																55
56	TI																																57
58	CI																																59
5K	BI				WI																												5S
5N																																	5J
5F																																	5L
60																																	61
62																																	63
64																																	65
66																																	67
68																																	69
6K																																	6S
6N																																	6J
6F																																	6L
70																																	71
72																																	73
74																																	75
76																																	77
78																																	79
7K																																	7S
7N																																	7J
7F																																	7L

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### 1.3 Flow Chart Key

# 1, PROGRAM, REFRACTION, AND PRECESSION CONSTANTS

C1	+ .2617993878 + 00	r/h
C2	+ .4363323130 - 02	r/m
C3	+ .7272205217 - 04	r/s
C4	+ .1745329252 - 01	r/°
C5	+ .2908882087 - 03	r/'
C6	+ .4848136811 - 05	r/"
C7	+ .1000000000 + 01	1.0
C8	+ .2000000000 + 03	200.0
C9	+ .7600000000 + 03	pressure
C10	+ .0000000000 + 00	temperature
C11	+ .3665000000 - 02	β
C12	+ .6370000000 + 07	R
C13	+ .2913756581 - 03	A' <sub>0</sub>
C14	+ .3227865000 - 06	A' <sub>1</sub>
C15	+ .1022500000 - 08	A' <sub>2</sub>
C16	+ .3600000000 + 04	unused
C17	+ .3600000000 + 04	
C18	+ .6000000000 + 02	
C19	+ .2640000000 - 02	C
C20	+ .3073270000 + 01	m <sup>s</sup>
C21	+ .1336170000 + 01	n <sup>s</sup>
C22	+ .1860000000 - 04	dm/dt <sup>s</sup>
C23	- .8500000000 - 04	dn/dt <sup>"</sup>
C24	+ .1570796327 - 01	r/grad
C25	+ .1570796327 - 01	π/2
C26	+ .1000000000 + 03	100.0

- I, 1      Input Constants  
 I, 21     Input first data card  
 II        If signal is minus go to Box III (station data), if plus go to  
           Box VI (point data).  
 III       Print identification  
 IV        Input station data (cards 2-12)  
           COMPUTE;  $[1] \bar{P}_a = P_a (1 - .00264 \cos 2 \phi - 2 \frac{H_a}{R})$   
 IVa       If signal is plus go to Box V.8 (using the  $\alpha, \omega, \kappa$  - system), if  
           minus go to Box IVb (convert A,  $\nu$ , ( $\kappa$ ) - system to  $\alpha, \omega, \kappa$  -  
           system)  
 IVb [2]   Given A,  $\nu$ , ( $\kappa$ ). Convert to  $\alpha, \omega, \kappa$  system by the following formulas:

$$\begin{aligned} K &= A - \pi \\ \tan K &= \frac{\sin K}{\cos K} \\ \cotan K &= \frac{1}{\tan K} \\ \tan \nu &= \frac{\sin \nu}{\cos \nu} \\ \sin \omega &= \sin \nu \sin K \\ \cos \omega &= + (1 - \sin^2 \omega)^{1/2} \\ \tan \omega &= \frac{\sin \omega}{\cos \omega}; \omega \text{ can only be } 0^\circ \text{ to } \pm 90^\circ \\ \sin \alpha &= \tan \omega \cotan K \\ \cos \alpha &= \frac{\cos \nu}{\cos \omega} \\ \tan \alpha &= \frac{\sin \alpha}{\cos \alpha} \\ \tan \Delta \kappa &= \frac{\tan \alpha}{\sin \omega} \text{ (check for quadrant)} \\ \kappa &= (\kappa) - \Delta \kappa + \frac{\pi}{2} \end{aligned}$$

V.8 [3] Compute the following auxiliaries:

$$\begin{aligned} A_1 &= - \cos \alpha \cos \kappa + \sin \alpha \sin \omega \sin \kappa \\ B_1 &= - \cos \omega \sin \kappa \\ C_1 &= + \sin \alpha \cos \kappa + \cos \alpha \sin \omega \sin \kappa \end{aligned}$$

\* [ ] Reference page (66).

$$\begin{aligned}
D &= + \sin \alpha \cos \omega \\
E &= + \sin \omega \\
F &= + \cos \alpha \cos \omega \\
A_2 &= - \cos \alpha \sin \kappa - \sin \alpha \sin \omega \cos \kappa \\
B_2 &= + \cos \omega \cos \kappa \\
C_2 &= + \sin \alpha \sin \kappa - \cos \alpha \sin \omega \cos \kappa
\end{aligned}$$

VI [3] Compute:

$$\begin{aligned}
\xi &= \frac{(\ell_{x-p}) A_1 + (\ell_{y-p}) A_2 + c D = u}{(\ell_{x-p}) C_1 + (\ell_{y-p}) C_2 + c F = w} \\
\eta &= \frac{(\ell_{x-p}) B_1 + (\ell_{y-p}) B_2 + c E = v}{(\ell_{x-p}) C_1 + (\ell_{y-p}) C_2 + c F = w}
\end{aligned}$$

VII [3] 1.  $\tan K' = \frac{\eta}{\xi}$ ; (check for quadrant:  $K = q + K'$ );  $A = K + \pi$   
2.  $\tan z_r = (\xi^2 + \eta^2)^{1/2}$

[1] 3.  $r = r_m \frac{\bar{P}_a(1 + \beta t_o)}{P_o(1 + \beta t_a)}$  where,

$$r_m = A_o' \tan z_r - A_1' \tan^3 z_r + A_2' \tan^5 z_r$$

4.  $z = z_r + r$

VIII Compute:  $\sin A, \cos A; \sin z, \cos z; \sin \phi, \cos \phi$

IX [4] 1.  $\sin \delta = \cos z \sin \phi - \sin z \cos A \cos \phi$   
2.  $\cos \delta \cos H' = \cos z \cos \phi + \sin z \cos A \sin \phi$   
3.  $\cos \delta \sin H' = \sin z \sin A$   
4.  $\tan H' = \frac{\cos \delta \sin H'}{\cos \delta \cos H'}$ , (check for quadrant)

X [4] 1.  $\cos \delta = + (1 - \sin^2 \delta)^{1/2}$ ;  $\tan \delta = \frac{\sin \delta}{\cos \delta}$ , ( $\delta$  can only be  $0^\circ$  to  $+90^\circ$ )  
2.  $\alpha^* (\text{R.A.}) = \text{S.T.} - H'$  (if  $\alpha^*$  is minus add  $2\pi$ )

$$\text{XI [4]} \quad 1. \quad \alpha_o = \alpha^* - \left[ (f+f') + g \sin (\alpha^* + G) \tan \delta + \frac{h \sin (\alpha^* + H)}{\cos \delta} \right]$$

$$2. \quad \delta_o = \delta - \left[ g \cos (\alpha^* + G) + h \cos (\alpha^* + H) \sin \delta + i \cos \delta \right]$$

$$\text{XII [4]} \quad 1. \quad \text{Ann. Var in R.A.} = m + n \sin \alpha_o \tan \delta_o$$

$$2. \quad \text{Ann. Var in Decl.} = n \cos \alpha_o$$

$$\text{XIII [4]} \quad 1. \quad \text{Sec. Var. in R.A.} = 100 \left[ n^2 \sin \alpha_o \cos \alpha_o (1 + 2 \tan^2 \delta_o) \right.$$

$$\left. + mn \cos \alpha_o \tan \delta_o + \frac{dm}{dt} + \frac{dn}{dt} \sin \alpha_o \tan \delta_o \right]$$

$$2. \quad \text{Sec. Var. in Decl.} = 100 \left[ -n^2 \sin^2 \alpha_o \tan \delta_o - mn \sin \alpha_o + \frac{dn}{dt} \cos \alpha_o \right]$$

$$\text{XIV [4]} \quad 1. \quad \alpha_{1950} = \alpha_o - \left[ A_{V_\alpha} (\Delta T) + S_{V_\alpha} \frac{(\Delta T)^2}{200} \right]$$

$$2. \quad \delta_{1950} = \delta_o - \left[ A_{V_\delta} (\Delta T) + S_{V_\delta} \frac{(\Delta T)^2}{200} \right]$$

XV Convert and Print (2 cards)

1. R.A. (hours, minutes, seconds)

2. Decl. (degrees, minutes, seconds)

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NOTE: Independent Star numbers G, H, g, h, i, (f + f') are taken from the "American Ephemeris and Nautical Almanac".

#### 1.4 The Code [6]

"The One Address Floating Binary (OFB) Code" devised by Lloyd Campbell, Computing Laboratory, was applied to this problem. Instructions on the use of the code may be found in BRL Report No. 997, October 1956, "Programming and Coding for Ordvac", by Tadeusz Leser and Michael Romanelli. This code has an internal computing capacity of 9 decimal digits.



# 1.4.1 Program

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
I.1	K40600		+ I.1		
.2	N00040	600	U OFB		Enter OFB
.3	K805K0		f+ B1		
.4	6002FS	601	fM I1		Set Format S10 - S2
.5	K805K1		f+ B2		
.6	6002FN	602	fM I2		
.7	0005K4		f+ W1		
.8	SNO262	603	U* IBMC		
.9	441003		ISA		
.10	000582	604	f+ C3	1	
.11	681593		fX C20	1	
.12	101593	605	fM C20	1	Read in constants
.13	I01604		IfC' I.10	1	
.14	000585	606	f+ C6		
.15	680596		fX C23		
.16	100596	607	fM C23		
.17	K805K2		f+ B3		
.18	6002FS	608	fM I1		Set Format S8 - S2
.19	K805K3		f+ B4		
.20	6002FN	609	fM I2		
I.21	0005K5		f+ W2		Read Parameter
.22	SNO262	60K	U* IBMC		Card
II.1	000563		f+ T4		
.2	440671	60S	fC' VI.1		
III.1	0005K5		f+ W2		Print Parameter
.2	SNO2FJ	60N	U* IBMR		Card
IV.1	000562		f+ T3		
.2	100531	60J	fM E1		Set E1
.3	442002		ISA	2	
.4	441003	60F	ISA	1	
.5	0005K5		f+ W2		
.6	SNO262	60L	U* IBMC		Read Cards 2 and 3
.7	002564		f+ T5	2	
.8	10251J	610	fM S30	2	+ Z → S30 (not used in Star Identification)
.9	302517		OM S24	2	
.10	001560	611	f+ T1	1	∅ → S24
.11	681583		fX C4	1	
.12	FN2517	612	f(+ )M S24	2	∅ <sub>0</sub> → S25 (not used in Star Identification)
.13	I01611		IfC' IV.10	1	
.14	I0260F	613	IfC IV.5	2	
.15	442004		ISA	2	
.16	441003	614	ISA	1	
.17	0005K5		f+ W2		
.18	SNO262	615	U* IBMC		
.19	302519		OM S26	2	S.T. → S26
.20	001560	616	f+ T1	1	S.T. <sub>0</sub> → S27 (not used in Star Identification)

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.21	681580		fx C1	1	
.22	FN2519	617	f(+)M S26	2	G → S28
.23	101616		IFC' IV.21	1	
.24	102614	618	IFC' IV.16	2	H → S29
.25	000518		f+ S28		
.26	100502	619	fm S3		G → S3
.27	00051N		f+ S29		
.28	100503	61K	fm S4		H → S4
.29	0005K5		f+ W2		
.30	SNO262	618	U* IBMC		
.31	000560		f+ T1		
.32	680582	61N	fx C3		
.33	100504		fm S5		
.34	441002	61J	ISA	1	(f+f') → S5
.35	001561		f+ T2	1	
.36	680585	61F	fx C6		
.37	101505		fm S6	1	g → S6
.38	F0161F	61L	IFC IV.36	1	h → S7
.39	0005K5		f+ W2		
.40	SNO262	620	U* IBMC		
.41	000560		f+ T1		
.42	000560	621	f+ T1		Unused
.43	680585		fx C6		
.44	100507	622	fm S8		i → S8
.45	000561		f+ T2		
.46	100508	623	fm S9		τ → S9
.47	000562		f+ T3		
.48	100509	624	fm S10		ΔT → S10
.49	0005K5		f+ W2		
.50	SNO262	625	U* IBMC		
.51	000560		f+ T1		
.52	10050K	626	fm S11		P <sub>a</sub> → S11
.53	000561		f+ T2		
.54	100508	627	fm S12		
.55	000565		f+ T6		
.56	10050J	628	fm S14		H <sub>a</sub> → S14
IV.57	NN0486		fU IV.80		
.58	NN0486	629	fU IV.80		Transfer to Compute $\bar{P}_a$
.59	001562		f+ T3	1	
.60	681583	62K	fx C4	1	Unused
.61	FN050N		f(+)M S13		
.62	F0162K	628	IFC IV.59	1	
.63	0005K5		f+ W2		
.64	SNO262	62N	U* IBMC		
.65	441003		ISA		
.66	001560	62J	f+ T1		α or A → S15
.67	680597		fx C24		ω or v → S16
.68	10150F	62F	fm S15		K or (K) → S17

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.69	10162J	62L	IFC' IV.66	1	Unused
.70	000500		f+ S1		
.71	0005K5	630	f+ W2		
.72	SN0262		U* IBMC		
.73	441003	631	ISA 1	1	
.74	001560		f+ T1	1	
.75	101511		FM S18	1	
.76	101631	632	IFC' IV,74	1	
.77	000598	633	f+ C25		
.78	N40598		f(+) C25		
.79	100514	634	FM S21		$\pi \rightarrow S21$
IVa.1	000531		f+ K1		$\alpha, \omega, K$ system go to V.
.2	2N0730	635	FC' V.8		$\alpha, \omega, (K)$ system go
IVb.1	00050F		f+ S15		to IVb
.2	N40514	636	f(-) S21		$K = A - \pi$
.3	100560		FM T1		
.4	000560	637	f+ T1		
.5	SN0111		U* sin-Cos		
.6	100560	638	FM T1		sin K
.7	000017		f+ O17		
.8	100561	639	FM T2		cos K
.9	000500		f+ S1		Unused
.10	00050L	63K	f+ S16		
.11	SN0111		U* sin-Cos		
.12	100562	63S	FM T3		sin v
.13	780017		f: O17		
.14	100563	63N	FM T4		tan v
.15	000017		f+ O17		
.16	100564	63J	FM T5		cos v
.17	000563		f+ T4		
.18	680561	63F	fx T2		tan $\alpha$
.19	100565		FM T6		
.20	000565	63L	f+ T6		
.21	SN03N0		U* arctan		
.22	000586	640	f+ C7		
.23	040568		f(-) T9		
.24	100568	641	FM T9		Unused
.25	000568		f+ T9		
.26	000568	642	f+ T9		$\cos \omega = +$
.27	SN01J2		U* $\sqrt{N}$		$(1 - \sin^2 \omega)^{1/2}$
.28	100568	643	FM T9		$\cos \omega \rightarrow T9$
.29	000567		f+ T8		
.30	780568	644	f: T9		$\tan \omega \rightarrow T6$
.31	100565		FM T6		
.32	NN0739	645	FU IVb.71		
.33	NN0739		FU IVb.71		
.34	100568	646	FM T9		Unused
.35	000565		f+ T6		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
IVb.36	000567		f+ T8		
.37	2N0652	647	fc IVb.58		
IVb.38	000514		f+ S21		$\pi = q$ (quadrant)
.39	100560	648	fm T1		
IVb.40	000562		f+ T3		
.41	780567	649	f; T8		
.42	100561	64K	fm T2		$\tan \Delta K' = \frac{\tan \alpha}{\sin \omega}$
.43	100561		fm T2		Unused
IVb.44	000561		f+ T2		
.45	SN03N0	64S	U* arctan		
.46	N40560		f(+) T1		$\Delta K'$
.47	100561	64N	fm T2		$\Delta K = \Delta K' + q$
IVb.48	000510		f+ S17		
.49	040561	64J	f(-) T2		
.50	N40598		f(+) C25		$K = (K) - \Delta K + \frac{\pi}{2}$
.51	100569	64F	fm T10		
.52	000569		f+ T10		
.53	SN01L1	64L	U* sin-Cos		
.54	100569		fm T10		
.55	000017	650	f+ 017		sin of angle in T10
.56	10056K		fm T11		
.57	NN065N	651	fu V.20		Cos of angle in T11
IVb.58	240567		f- T8		
.59	2N0654	652	fc IVb.62		
IVb.60	300560		OM T1		$0 = q$ (quadrant)
.61	NN0646	653	fu IVb.40		
IVb.62	000562		f+ T3		
.63	2N0657	654	fc IVb.68		
IVb.64	000598		f+ C25		
.65	N40514	655	f(+) S21		
.66	100561		fm T2		$\pi + \frac{\pi}{2} = \Delta K$
.67	NN064J	656	fu IVb.48		
IVb.68	000598		f+ C25		
.69	100561	657	fm T1		
.70	NN064J		fu IVb.48		
V.1	000500	658	f+ S1		
.2	00150F		f+ S15		
.3	SN01L1	659	U* sin-Cos		Unused
.4	101565		fm T6		
.5	000017	65K	f+ 017		
.6	101566		fm T7		
.7	000500	65S	f+ S1		
V.20	000565		f+ T6		
.21	680567	65N	fx T8		
.22	680569		fx T10		
.23	100570	65J	fm T17		A1 → T17
.24	240566		f- T7		
.25	68056K	65F	fx T11		
.26	FN0570		f(+)M T17		
.27	240568	65L	f- T9		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.28	680567	660	fx T10		B1 → T20
.29	100573		fm T20		
.30	000566	661	f+ T7		
.31	680567		fx T8		
.32	680569	662	fx T10		
.33	100576		fm T23		
.34	000565	663	f+ T6		
.35	68056K		fx T11		
.36	FN0576	664	f(+)M T23		C1 → T23
.37	000565		f+ T6		
.38	680568	665	fx T9		
.39	100572		fm T20		
.40	000567	666	f+ T8		E → T22
.41	100575		fm T22		
.42	000566	667	f+ T7		
.43	680568		fx T9		
.44	100578	668	fm T25		F → T25
.45	240565		f- T6		
.46	680567	669	fx T8		
.47	68056K		fx T11		
.48	100571	66K	fm T18		
.49	240566		f- T7		
.50	680569	66S	fx T10		A2 → T18
.51	FN0571		f(+)M T18		
.52	000568	66N	f+ T9		
.53	68056K		fx T11		
.54	100574	66J	fm T21		B2 → T21
.55	240566		f- T7		
.56	680567	66F	fx T8		
.57	68056K		fx T11		
.58	100577	66L	fm T24		
.59	000565		f+ T6		
.60	680569	670	fx T10		C2 → T24
.61	FN0577		f(+)M T24		
.62	NN060K	671	fu I.21		
VI.1	000565		f+ T6		
.2	100545	672	fm P6		
.3	000560		f+ T1		
.4	040512	673	f(-) S19		$(l_x - x_p) \rightarrow T7$
.5	100566		fm T7		
.6	000561	674	f+ T2		
.7	040513		f(-) S20		
.8	100567	675	fm T8		$(l_y - y_p) \rightarrow T8$
.9	000511		f+ S18		
.10	100568	676	fm T9		c → T9
VI.11	443003		ISA	3	
.12	442000	677	ISA	2	
VI.13	441003		ISA	1	
.14	303560	678	OM T1	3	
VI.15	001566		f+ T7	1	

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.16	682570	679	fx T17	2	
.17	FN3560		f(+ )M T1	3	
.18	F82001	67K	T1A	2	
VI.19	L01678		IPC' VI.15	1	
VI.20	L03677	67S	IPC VI.14	3	
VI.21	000560		f+ T1		
.22	780562	67N	f <sub>2</sub> T3		$\xi \rightarrow T7$
.23	100566		fM T7		
.24	000561	67J	f+ T2		
.25	780562		f <sub>2</sub> T3		
.26	100567	67F	fM T8		$\eta \rightarrow T8$
VII.1	000586		f+ T7		
.2	100530	67L	fM B0		Set B0(+)
VII.3	000566		f+ T7		
.4	4N0686	680	PC' VII.17		
VII.5	000514		f+ S21		
.6	100560	681	fM T1		$\pi \rightarrow T1$
VII.7	000567		f+ T8		
.8	780566	682	f <sub>2</sub> T7		$\tan K' = \eta/\xi$
.9	100561		fM T2		
.10	000561	683	f+ T3		
.11	SN03N0		U* arctan		
.12	N40560	684	f(+ ) T1		$K = q + K'$ , where q indicates the quadrant.
.13	100562		fM T3		
VII.14	000530	685	f+ B0		
.15	2N068J		PC VII.30		
.16	NN06N0	686	fU X.1		
VII.17	240566		f- T7		
.18	4N0688	687	PC' VII.21		
VII.19	300560		OM T1		
.20	1N0681	688	fU' VII.7		
VII.21	000567		f+ T8		
.22	4N068S	689	PC' VII.27		
VII.23	000598		f+ C25		
.24	N40514	68K	f(+ ) S21		$K = \pi + \pi/2 \rightarrow T3$
.25	100562		fM T3		
.26	NN0685	68S	fU VII.14		
VII.27	000598		f+ C25		
.28	100562	68N	fM T3		$K = \pi/2 \rightarrow T3$
.29	NN0685		fU VII.14		
VII.30	000562	68J	f+ T3		
.31	N40514		f(+ ) S21		
.32	100560	68F	fM T1		$A = K + \pi$
.33	000517		f+ S24		
.34	100500	68L	fM S1		$\phi \rightarrow S1$
.35	000519		f+ S26		
.36	100501	690	fM S2		S.T. $\rightarrow S2$
VII.37	240586		f- C7		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.38	100530	691	FM NO		
.39	NN0692		FU VII.41		
VII.40	000566	692	f+ T7		
.41	680566		fx T7		
.42	100566	693	FM T7		
.43	000567		f+ T8		
.44	680567	694	fx T8		
.45	FN0566		f(+)M T7		
.46	000566	695	f+ T7		
.47	SN01J2		U* $\sqrt{N}$		$\tan z_r = + (\xi^2 + \eta^2)^{1/2}$
.48	100568	696	FM T9		
.49	NN06K0		FU VII.69		
.50	N40500	697	f(+) S1		
.51	10056F		FM T15		
.52	00056F	698	f+ T15		
.53	SN01L1		U* sin-Cos		
.54	000017	699	f+ 017		
.55	10056F		FM T15		
.56	000592	69K	f+ C19		
.57	68056F		fx T15		
.58	10056F	69S	FM T15		Unused
.59	00050J		f+ S14		
.60	78058S	69N	f+ C12		
.61	10056L		FM T16		
.62	FN056L	69J	f(+)M T16		
.63	000586		f+ C7		
.64	04056F	69F	f(-) T15		
.65	04056L		f(-) T16		
.66	68050K	69L	fx S11		
.67	10050K		FM S11		
.68	000568	6K0	f+ T9		
.69	680568		fx T9		
.70	10056K	6K1	FM T11		
.71	680568		fx T9		
.72	100568	6K2	FM T12		
.73	68058J		fx C14		
.74	10056N	6K3	FM T13		r → T11
.75	00056K		f+ T11		
.76	680568	6K4	fx T12		
.77	68058F		fx C15		
.78	04056N	6K5	f(-) T13		
.79	10056K		FM T11		
.80	000568	6K6	f+ T9		
.81	68058N		fx C13		
.82	FN056K	6K7	f(+)M T11		
.83	000508		f+ S12		
.84	68058K	6K8	fx C11		
.85	N40586		f(+) C7		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.86	680588	6K9	fx C9		
.87	100568		fm T12		
.88	000589	6KK	f+ C10		
.89	68058K		fx C11		
.90	N40586	6KS	f(+) C7		
.91	68050K		fx S11		
.92	780568	6KN	f+ T12		
.93	68056K		fx T11		
.94	10056K		fm T11		
.95	000500	6KJ	f+ S1		Unused
.96	000568		f+ T9		
.97	SN03NO	6KF	U* arctan		z → T2
.98	100561		fm T2		
.99	N456K	6KL	f(+) T11		
VIII.1	100561		fm T2		
.2	000500	6SO	f+ T1		
.3	100562		fm T3		
.4	441003	6S1	ISA	1	
.5	001560		f+ T1		
.6	SN011L	6S2	U* sin-Cos	1	
.7	101563		fm T4		
.8	000017	6S3	f+ O17	1	sin-Cos A, z, $\phi$
.9	101566		fm T7	1	
.10	F01682	6S4	IfC VIII.5	1	
IX.1	000500		f+ S1		
.2	240564	6S5	f+ T5		Unused
.3	680566		fx T7		
.4	680568	6S6	fx T9		
.5	100569		fm T10		
.6	000567	6S7	f+ T8		
.7	680565		fx T6		
.8	FN0569	6S8	f(+)M T10		sin $\delta$ → T10
.9	000564		f+ T5		
.10	680566	6S9	fx T7		
.11	680565		fx T6		
.12	100566	6SK	fm T11		
.13	000567		f+ T8		
.14	680568	6SS	fx T9		
.15	FN0566		f(+)M T7		
.16	000564	6SN	f+ T5		Cos $\delta$ Cos $H'$ → T7
.17	680563		fx T4		
.18	100567	6SJ	fm T8		Cos $\delta$ sin $H'$ → T8
.19	1N067L		fu' VII.3		
.20	00056K	6SF	f+ T11		
.21	000567		fm T8		
.22	1N067L	6SL	fu' VII.3		Unused
X.1	000569		f+ T10		
.2	680569	6NO	fx T10		
.3	100560		fm T1		
.4	000586	6N1	f+ C7		



SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.5	040560		f(-) T1		
.6	100560	6N2	fM T1		
.7	000560		f+ T1		
.8	8N01J2	6N3	U* $\sqrt{N}$		
.9	10056K		fM T11		
.10	000569	6N4	f+ T10		
.11	78056K		f+ T11		
.12	100568	6N5	fM T12		
.13	000568		f+ T12		
.14	8N03N0	6N6	U* arctan		
.15	10056N		fM T13		
.16	000501	6N7	f+ S2	*	$\delta \rightarrow T13$
.17	040562		f(-) T3		
.18	100562	6N8	fM T3		$\alpha^* = S.T. - H^* \rightarrow T3$
XI.1	000562		f+ T3		
.2	2N06NN	6N9	fC XI.7		
XI.3	000514		f+ S21		
.4	N40514	6NK	f(+) S21		
.5	N40562		f(+) T3		
.6	100562	6NS	fM T3		
XI.7	441002		ISA	1	
XI.8	000562	6NN	f+ T3		
.9	N41502		f(+) S3	1	
.10	101563	6NJ	fM T4	1	
.11	001563		f+ T4		
.12	8N01L1	6NF	U* sin-Cos	1	
.13	101565		fM T6		
.14	000017	6NL	f+ 017		$\sin (\alpha^* + G) \rightarrow T6$
XI.15	101567		fM T8	1	
.16	1016NN	6JO	Ifc' XI.8	1	$\cos (\alpha^* + G) \rightarrow T8$
.17	NN06J3		fU XI.21		
.18	000500	6J1	f+ S1		
.19	000500		f+ S1		
.20	000500	6J2	f+ S1		Unused
XI.21	000566		f+ T7	*	
.22	78056K	6J3	f+ T11		
.23	680506		fX S7		
.24	100560	6J4	fM T1		
.25	000505		f+ S6		
.26	680565	6J5	fX T6		
.27	680568		fX T12		
.28	FN0560	6J6	f(+)M T1		
.29	000504		f+ S5		
.30	FN0560	6J7	f(+)M T1		
.31	000562		f+ T3		
.32	040560	6J8	f(-) T1		
.33	100515		fM S22		
.34	000505	6J9	f+ S6	*	$\alpha_o \rightarrow S22$
.35	680567		fX T8		
.36	100567	6JK	fM T2		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.37	000506	6JS	f+ S7		
.38	680568		fx T9		
.39	680569	6JN	fx T10		
.40	FN0561		f(+)M T2		
.41	000507	6JJ	f+ S8		
.42	68056K		fx T11		
.43	FN0561	6JF	f(+)M T2		
.44	00056N		f+ T13		
.45	040561	6JL	f(-) T2		
.46	100516		fM S23		$\delta_o \rightarrow S23$
XII.1	000515	6F0	f+ S23		
.2	SN01L1		U* sin-Cos		
.3	100562	6F1	fM T3		$\sin \alpha_o \rightarrow T3$
.4	000017		f+ 017		
.5	100563	6F2	fM T4		$\cos \alpha_o \rightarrow T4$
.6	000500		f+ S1		Unused
.7	000516	6F3	f+ S23		
.8	SN01L1		U* sin Cos		
.9	780017	6F4	f+ 017		
.10	100564		fM T5		$\tan \delta_o \rightarrow T5$
.11	000594	6F5	f+ C21		
.12	680562		fx T3		
.13	680564	6F6	fx T5		
.14	N40593		f(+) C20		
.15	100560	6F7	fM T1		$A_{v\alpha} \rightarrow T1$
.16	000594		f+ C21		
.17	680563	6F8	fx T4		$A_{v\delta} \rightarrow T2$
.18	100561		fM T2		
XIII.1	000564	6F9	f+ T5		
.2	680564		fx T5		
.3	100565	6FK	fM T6		
.4	FN0565		f(+)M T6		
.5	000586	6FS	f+ C7		
.6	FN0565		f(+)M T6		
.7	000594	6FN	f+ C21		
.8	680594		fx C21		
.9	680562	6FJ	fx T3		
.10	680563		fx T4		
.11	680565	6FT	fx T6		
.12	100565		fM T6		
.13	000593	6FL	f+ C20		
.14	680594		fx C21		
.15	680563	6LO	fx T4		
.16	680564		fx T5		
.17	FN0565	6L1	f(+)M T6		
.18	000595		f+ C22		
.19	FN0565	6L2	f(+)M T6		
.20	240596		f- C23		
.21	680562	6L3	fx T3		
.22	680564		fx T5		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.23	FNO565		f(+M T6		
.24	000565	6L4	f+ T6		
.25	680599		fx C26		$S_{V\alpha} \rightarrow T6$
.26	100565	6L5	fm T6		
.27	240594		f- C21		
.28	680594	6L6	fx C21		
.29	100566		fm T7		
.30	000562	6L7	f+ T3		
.31	680562		fx T3		
.32	680566	6L8	fx T7		
.33	680564		fx T5		
.34	100566	6L9	fm T7		
.35	240593		f- C20		
.36	680594	6LK	fx C21		
.37	680562		fx T3		
.38	FNO566	6LS	f(+M T7		
.39	000596		f+ C23		
.40	680563	6LN	fx T4		
.41	FNO566		f(+M T7		
.42	000566	6LJ	f+ T7		
.43	680599		fx C26		$S_{V\delta} \rightarrow T7$
.44	100566	6LF	fm T7		
.45	NN0700		PU XIV.1		
.46	000500	6LL	f+ T1		Unused
XIV.1	000509		f+ S10		
.2	680509	700	fx S10		
.3	780587		f+ C8		
.4	100562	701	fm T3		
.5	680565		fx T6		
.6	100565	702	fm T6		
.7	000509		f+ S10		
.8	680560	703	fx T1		
.9	FNO565		f(+M T6		
.10	000515	704	f+ S22		
.11	040565		f(-) T6		
.12	100520	705	fm D1		$\alpha_{1950} \rightarrow D1$
.13	000562		f+ T3		
.14	680566	706	fx T7		
.15	100566		fm T7		
.16	000509	707	f+ S10		
.17	680561		fx T2		
.18	FNO566	708	f(+M T7		
.19	000516		f+ S23		
.20	040566	709	f(-) T7		
.21	100521		fm D2		$\delta_{1950} \rightarrow D2$
.22	000500	70K	f+ S1		Unused
XV.1	441002		ISA		
.2	F40520	70S	f+ D1	1	
.3	780582		f+ C3		
.4	100546	70N	fm P7		$ \alpha'_{1950}  \rightarrow P7$

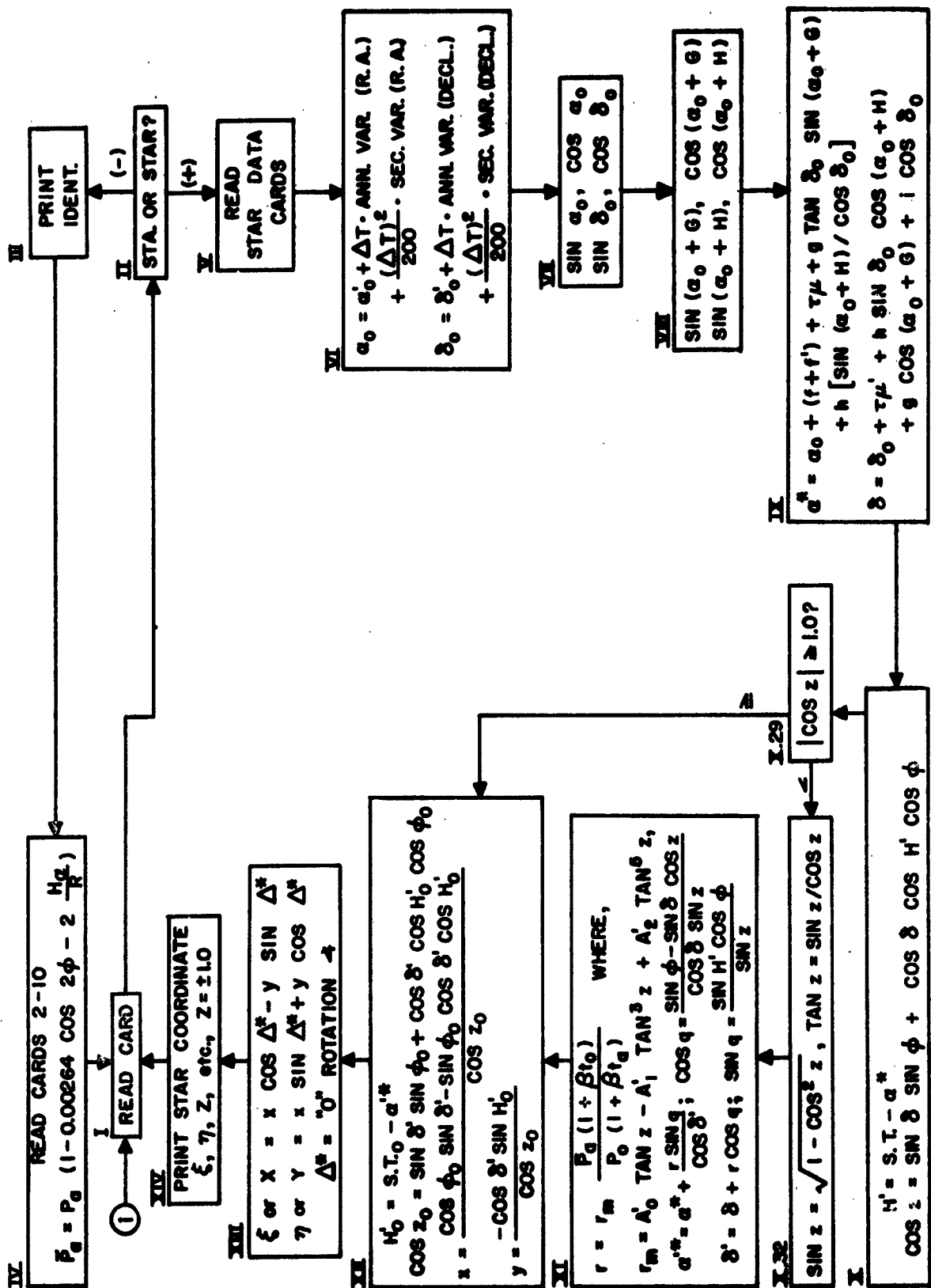
SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.5	F40521	70J	f +  D2		
.6	780585		f; C6		
.7	100547	70F	FM P8		
XV.8	300543		OM P4		↑  8" 1950  → P8
.9	300540	70L	OM P1		
.10	300541		OM P2		
XV.11	001546	710	f+ P7	1	
.12	04158L		f(-) C16	1	
.13	101546	711	FM P7	1	
.14	4N0713		FC' 64.1		
XV.15	N4158L	712	f(+) C16	1	
.16	101546		FM P7	1	
.17	1N0715	713	FU' XV.22		
XV.18	000540		f+ P1		
.19	N40586	714	f(+) C7		
.20	100540		FM P1		
.21	NN0710	715	FU XV.11	1	Convert α to
XV.22	001546		f+ P7		hours, minutes, seconds
.23	040591	716	f(-) C18	1	and δ to degrees,
.24	101546		FM P7		minutes and seconds.
.25	2N0718	717	FC XV.27		
.26	NN071K		FU XV.31		
XV.27	000541	718	f+ P2		
.28	N40586		f(+) C7		
.29	100541	719	FM P2		
.30	1N0715		FU' XV.22		
XV.31	N40591	71K	f(+) C18		
.32	100542		FM P3		
.33	000543	71S	f+ P4		
.34	N40586		f(+) C7		
.35	100543	71N	FM P4		
.36	300544		OM P5		
XV.37	001520	71J	f+ D1	1	*
.38	2N0720		FC XV.43		
XV.39	442003	71F	ISA	2	
XV.40	642540		f -  P1	2	Test for -α or - δ.
.41	102540	71I	FM P1	2	
.42	L0271F		IfC' XV.40	2	
XV.43	000720	720	f+ W4		Print
.44	SN02FJ		U* IEMR		
XV.45	L0170F	721	IfC' XV.8	1	Next Case
.46	NN060K		FU I.21		
V.8	441003	730	ISA	1	
.9	442000		ISA	2	
.10	00250F	731	f+ S15		
.11	SN01L1		U* sin-cos	2	
.12	101565	732	FM T6	1	
.13	000017		f+ 017		
.14	101566	733	FM T7	1	
.15	F81001		IIA	1	

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.16	F82001	734	IIA	2	
.17	F01731	734	IFC V.10	1	
.18	NN065N	735	FU V.20		
.19	NN065N	735	FU V.20		
VIIa.1	000561	736	f+ T2		
.2	SN03NO	736	U* arctan		
.3	100562	737	fM T3		Unused
.4	N40560	737	f(+) T1		
.5	100562	738	fM T3		
.6	NN0685	738	FU VII.14		
IVb.71	000560	739	f+ T1		
.72	780561	739	f; T2		
.73	100560	73K	fM T1		tan K → T1
.74	000586	73K	f+ C7		
.75	780560	738	f; T1		
.76	680565	738	fx T6		
.77	100565	73N	fM T6		sin α → T6
.78	000564	73N	f+ T5		
.79	780568	73J	f; T9		Cos α → T7
.80	100566	73J	fM T7		
.81	000565	73F	f+ T6		
.82	780566	73F	f; T7		
.83	100562	73L	fM T3		tan α → T3
.84	NN0647	73L	FU IVb.36		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
	K20K2K				
	2K02K2	5K0	B1		Format S10 - S2
	N00000				
	000000	5K1	B2		
	820828				
	280282	5K2	B3		Format S8 - S2
	820N00				
	000000	5K3	B4		
	05001K				
	100580	5K4	W1		Input C1 - C26
	060006				
	100560	5K5	W2		Input data and print identification
	060003				
	100563	5K6	W3		Unused
	060006				
	100540	5K7	W4		Print Output Data
	060006				
	100511	5K8	W5		Unused
	800003				
	2004S6				Key Word
IV.80	000517	4S6	f+ S24		
.81	N40517		f(+) S24		
.82	10050F	4S7	fM S15		
.83	10050F		fM S15		
.84	00050F	4S8	f+ S15		
.85	SN011L1		U* sin-cos		
.86	000017	4S9	f+ 017		
.87	10050F		fM S15		
.88	000592	4SK	f+ C19		
.89	68050F		fx S15		
.90	10050F	4SS	fM S15		
.91	00050J		f+ S14		
.92	78058S	4SN	f+ C12		
.93	10050L		fM S16		
.94	FN050L	4SJ	f(+)M S16		$\bar{P}_a \rightarrow S11$
.95	000586		f+ C7		
.96	04050F	4SF	f(-) S15		
.97	04050L		f(-) S16		
.98	68050K	4SL	fx S11		
.99	10050K		fM S11		
.100	NN062N	4NO	fU IV.63		
.101	NN062N		fU IV.63		

## **2. COMPUTATION OF STANDARD COORDINATES**

### **2.1 Flow Chart**





## 2.2 Raster

	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	
00																																	01
02																																	03
04																																	05
06																																	07
08																																	09
0K																																	0S
0N																																	0J
0F																																	0L
10																																	11
12																																	13
14																																	15
16																																	17
18																																	19
1K																																	1S
1N																																	1J
1F																																	1L
20																																	21
22																																	23
24																																	25
26																																	27
28																																	29
2K																																	2S
2N																																	2J
2F																																	2L
30																																	31
32																																	33
34																																	35
36																																	37
38																																	39
3K																																	3S
3N																																	3J
3F																																	3L
	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	

	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	0	1	2	3	4	5	6	7	8	9	K	S	N	J	F	L	
40																																	41
42																																	43
44																																	45
46																																	47
48																																	49
4K																																	4S
4N																																	4J
4F																																	4L
50	SI																																51
52	DI																																53
54	PI																																55
56	TI																																57
58	CI																																59
5K	BI																																5S
5N																																	5J
5F																																	5L
60																																	61
62																																	63
64																																	65
66																																	67
68																																	69
6K																																	6S
6N																																	6J
6F																																	6L
70																																	71
72																																	73
74																																	75
76																																	77
78																																	79
7K																																	7S
7N																																	7J
7F																																	7L

### 2.3 Flow Chart Key

1, Program and refraction constants same as Star Identification.

I, II, and III Same as Star Identification

IV Input Station Data (Cards 2-10)

$$\text{COMPUTE: } [1] \bar{P}_a = P_a (1 - .00264 \cos 2 \phi - 2 \frac{H}{R}) \quad (\bar{P}_a \text{ used in Pex XI})$$

V Input Star Data Cards

$$\text{VI [5]} \quad \alpha_o = \alpha_o' + \Delta T \cdot \text{Annual Variation (R.A.)} + \frac{(\Delta T)^2}{200} \cdot \text{sec. var. (R.A.)}$$

$$\delta_o = \delta_o' + \Delta T \cdot \text{Annual Variation (Decl.)} + \frac{(\Delta T)^2}{200} \cdot \text{sec. var. (Decl.)}$$

$$\text{VII} \quad 1. \sin \alpha_o, \cos \alpha_o$$

$$2. \sin \delta_o, \cos \delta_o$$

$$\text{VIII} \quad 1. \sin (\alpha_o + G)^*, \cos (\alpha_o + G)^*$$

$$2. \sin (\alpha_o + H)^*, \cos (\alpha_o + H)^*$$

\*If  $(\alpha_o + G)$  or  $(\alpha_o + H) \geq 24$  hours, the subroutine adjusts the angle.

$$\text{IX [5]} \quad \alpha^* = \alpha_o + (f + f') + \tau \mu + g \tan \delta_o \sin (\alpha_o + G) + h \left[ \sin (\alpha_o + H) / \cos \delta_o \right]$$

$$\delta = \delta_o + \tau \mu' + h \sin \delta_o \cos (\alpha_o + H) + g \cos (\alpha_o + G) + i \cos \delta_o$$

$$\text{X [5]} \quad H' = \text{S.T.} - \alpha^*$$

$$\cos z = \sin \delta \sin \phi + \cos \delta \cos H' \cos \phi, \text{ If } |\cos z| \geq 1.0 \text{ go to XII}$$

$$\sin z = (1 - \cos^2 z)^{1/2}$$

$$\tan z = \sin z / \cos z$$

$$\text{XI [1]} \quad r = r_m \frac{\bar{P}_a (1 + \beta t_o)}{P_o (1 + \beta t_a)}, \text{ where, } r_m = A_o' \tan z - A_1' \tan^3 z + A_2' \tan^5 z$$

$$[4] \quad \alpha^{**} = \alpha^* + \frac{r \sin q}{\cos \delta'}; \cos q = \frac{\sin \phi - \sin \delta \cos z}{\cos \delta \sin z}$$

$$\delta' = \delta + r \cos q; \sin q = \frac{\sin H' \cos \phi}{\sin z}$$

•

\*\* XII [4]  $H'_0 = S.T._0 - \alpha'^*$  ;  $\cos z_0 = \sin \delta' \sin \phi_0 + \cos \delta' \cos H'_0 \cos \phi_0$

$$x = \frac{\cos \phi_0 \sin \delta' - \sin \phi_0 \cos \delta' \cos H'_0}{\cos z_0}$$

$$y = \frac{-\cos \delta' \sin H'_0}{\cos z_0}$$

XIII  $X = x \cos \Delta^* - y \sin \Delta^*$

$$Y = x \sin \Delta^* + y \cos \Delta^*$$

when,

$\Delta^* = "00"$  (rotation angle positive from north to east), north = +x  
east = +y

XIV Print card number 2 (Star Coordinate)

$\xi, \eta, Z$ , wt, Boss no., pt. no., (Input for camera orientation code) where,

$Z = \pm 1.0$ , X is  $\xi$  and Y is  $\eta$ .

Option prints:

$\xi, \eta, Z$ , Boss no. type, point no.

---

\*\* In order to refer the Standard Coordinates to an arbitrarily chosen position of origin on the earth, a set of corresponding reference parameters  $\phi_0$  and  $S.T._0$  can be introduced. If the Standard Coordinates are to be computed in the local system in which the refraction was computed, the  $\phi_0$  and  $S.T._0$  values must be identical to the local values.

#### 2.4 The Code [6]

# 2.4.1 Program

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
I.1	R40600		+ I.1		Enter OfB
.2	N00040	600	U OfB		
.3	K805K0		f+ B1		Set Format S10 - S2
.4	6002FS	601	fM I1		
.5	K805K1		f+ B2		
.6	6002FN	602	fM I2		
.7	0005K4		f+ W1		
.8	SN0262	603	U* IBMC		
.9	441003		ISA		
.10	000582	604	f+ C3	1	
.11	681593		fX C20	1	Read in Constants
.12	101593	605	fM C20	1	
.13	I01604		IfC' I.10		
.14	000585	606	f+ C6	1	
.15	680596		fX C23		
.16	100596	607	fM C23		
.17	K805K2		f+ B3		Set Format S8 - S2
.18	6002FS	608	fM I1		
.19	K805K3		f+ B4		
.20	6002FN	609	fM I2		
I.21	0005K5		f+ W2		Read Parameter Card
.22	SN0262	60K	U* IBMC		
II.1	000563		f+ T4		
.2	2N0430	60S	fC' VI.1		
III.1	0005K5		f+ W2		Print Parameter Card
.2	SN02FJ	60N	U* IBMR		
IV.1	000562		f+ T3		
.2	100531	60J	fM E1		
.3	442002		ISA	2	
.4	441003	60F	ISA	1	
.5	0005K5		f+ W2		Read Cards 2 and 3
.6	SN0262	60L	U* IBMC		
.7	002564		f+ T3	2	+ Z → S30
.8	10251J	610	fM S30	2	
.9	302517		OM S24	2	
.10	001560	611	f+ T1	1	
.11	681583		fX C4	1	ϕ → S24 ϕ <sub>0</sub> → S25
.12	FN2517	612	f(+ )M S24	2	
.13	I01611		IfC' IV.10	1	
.14	I0260F	613	IfC' IV.5	2	
.15	442004		ISA	2	
.16	441003	614	ISA	1	
.17	0005K5		f+ W2		
.18	SN0262	615	U* IBMC		
.19	302519		OM S26	2	
.20	001560	616	f+ T1	1	



SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.21	681580		fx C1	1	S.T. → S26
.22	FN2519	617	f(+)M S26	2	S.T. <sub>0</sub> → S27
.23	L01616	618	Ifc' IV.21	1	G → S28
.24	L02614		Ifc' IV.16	2	H → S29
IV.25	000518	619	f+ S28		G → S3
.26	100502		fM S3		
.27	00051N	61K	f+ S29		H → S4
.28	100503		fM S4		
.29	0005K5	61S	f+ W2		
.30	SNO262		U* IBMC		
.31	000560	61N	f+ T1		
.32	680582		fx C3		
.33	100504	61J	fM S5	1	(f + f') → S5
.34	441002		ISA		
.35	001561	61F	f+ T2	1	
.36	680585		fx C6		
.37	101505	61L	fM S6	1	g → S6
.38	F0161F		Ifc IV.36	1	h → S7
.39	0005K5	620	f+ W2		
.40	SNO262		U* IBMC		
.41	000560	621	f+ T1		Unused
.42	000560		f+ T1		
.43	680585	622	fx C6		1 → S8
.44	100507		fM S8		
.45	000561	623	f+ T2		τ → S9
.46	100508		fM S9		
.47	000562	624	f+ T3		ΔT → S10
.48	100509		fM S10		
.49	0005K5	625	f+ W2		
.50	SNO262		U* IBMC		
.51	000560	626	f+ T1		P <sub>a</sub> → S11
.52	10050K		fM S11		
.53	000561	627	f+ T2		
.54	10050S		fM S12		
.55	000565	628	f+ T6		H <sub>a</sub> → S14
.56	10050J		fM S14		
.57	441003	629	ISA	1	
.58	30050N		OM S13		
.59	001562	62K	f+ T3	1	Rotation angle
.60	681583		fx C4		
.61	FN050N	62S	f(+)M S13	1	
.62	F0162K		Ifc IV.59		
.63	NN0486	62N	fU IV.80		Unused
.64	NN0486		fU IV.80		
.65		62J			62J - 62L available
.66					
	800003				Key Word
	200430				

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
V.1	000565		f+ T6		
.2	100545	430	fM P6		Pt No.
.3	000564		f+ T5		
.4	100544	431	fM P5		Boss No.
.5	300543		OM P4		
.6	300543	432	OM P4		Unused
.7	00051J		f+ S30		
.8	100542	433	fM P3		+ Z
.9	000560		f+ T1		
.10	680580	434	fx C1		
.11	100520		fM D1		
.12	000561	435	f+ T2		
.13	680581		fx C2		
.14	N40520	436	f(+) D1		$\alpha'_0$
.15	100520		fM D1		
.16	000562	437	f+ T3		
.17	680582		fx C3		
.18	N40520	438	f(+) D1		
.19	100520		fM D1		
.20	100520	439	fM D1		Unused
.21	0005K5		f+ W2		
.22	SN0262	43K	U* IBMI		
.23	000560		f+ T1		
.24	680582	43S	fx C3		
.25	100521		fM D2		
.26	000560	43N	f+ T2		$A_{v\alpha}$
.27	680582		fx C3		
.28	100522	43J	fM D3		$S_{v\delta}$
.29	000562		f+ T3		
.30	680582	43F	fx C3		
.31	100523		fM D4		$\mu$
.32	100523	43L	fM D4		Unused
V.33	0005K5		f+ W2		
.34	SN0262	440	U* IBMC		
.35	000560		f+ T1		
.36	680583	441	fx C4		
.37	100524		fM D5		
.38	000561	442	f+ T2		$\delta'_0$
.39	680584		fx C5		
.40	N40524	443	f(+) D5		
.41	100524		fM D5		
.42	000562	444	f+ T3		
.43	680585		fx C6		
.44	N40524	445	f(+) D5		
.45	100524		fM D5		
.46	100524	446	fM D5		Unused
.47	0005K5		f+ W2		
.48	SN0262	447	U* IBMC		
.49	000560		f+ T1		
.50	680585	448	fx C6		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.51	100525		FM D6		$\downarrow$ $\begin{matrix} A_v \\ \alpha \\ S_v \\ \delta \end{matrix}$
.52	000561	449	f+ T2		
.53	680585	44K	fx C6		
.54	100526		FM D7		
.55	000562	44S	f+ T3		
.56	680585		fx C6		
.57	100527	44N	FM D8		$\mu^*$ Unused
.58	100527		FM D8		
VI.1	000509	44J	f+ S10		
.2	680509		fx S10		
.3	780587	44F	f+ C8		
.4	100560		FM T1		
.5	680522	44L	fx D3		
.6	100522		FM D3		
.7	000560	450	f+ T1		
.8	680526		fx D7		
.9	100526	451	FM D7		
.10	000509		f+ S10		
.11	680521	452	fx D2		
.12	N40522		f(+) D3		
.13	N40520	453	f(+) D1		
.14	100520		FM D1		$\alpha_0 \rightarrow D1$
.15	000509	454	f+ S10		
.16	680525		fx D6		
.17	N40526	455	f(+) D7		
.18	N40524		f(+) D5		
.19	100524	456	FM D5		$\delta_0 \rightarrow D5$ Unused
.20	100524		FM D5		
VII.1	000520	457	f+ D1		
.2	SN0111		U* sin-cos		
.3	100560	458	FM T1		
.4	000017		f+ O17		$\sin \alpha_0$
.5	100561	459	FM T2		$\cos \alpha_0$
.6	100561		FM T2		Unused
.7	000524	45K	f+ D5		
.8	SN0111		U* sin-cos		
.9	100562	45S	FM T3		
.10	000017		f+ O17		$\sin \delta_0$
.11	100563	45N	FM T4		$\cos \delta_0$
.12	000520		f+ D1		
VIII.1	N40502	45J	f(+) S3		$(\alpha_0 + G)$
.2	100564		FM T5		
.3	000564	45F	f+ T5		
.4	SN0111		U* sin-cos		
.5	100564	45L	FM T5		$\sin (\alpha_0 + G)$
.6	000017		f+ O17		
.7	100565	460	FM T6		$\cos (\alpha_0 + G)$
.8	000520		f+ D1		
.9	N40503	461	f(+) S4		$(\alpha_0 + H)$
.10	100566		FM T7		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.11	000566	462	f+ T7		
.12	SN0111		U* sin-cos		
.13	100566	463	fM T7		
.14	000017		f+ 017		$\sin(\alpha_0 + H)$
.15	100567	464	fM T8		$\sin(\alpha_0 + H)$
.16	000562		f+ T3		
IX.1	780563	465	f+ T4		
.2	680564		fx T5		
.3	680505	466	fx S6		
.4	N40520		f(+) D1		
.5	N40504	467	f(+) S5		
.6	100520		fM D1		
.7	000508	468	f+ S9		$\alpha^* \rightarrow D1$
.8	680523		fx D4		
.9	N40520	469	f(+) D1		
.10	100520		fM D1		
.11	000566	46K	f+ T7		
.12	780563		f+ T4		
.13	680506	46S	fx S7		
.14	N40520		f(+) D1		
.15	100520	46N	fM D1		
.16	000508		f+ S9		
.17	680527	46J	fx D8		
.18	N40524		f(+) D5		
.19	100524	46F	fM D5		
.20	000567		f+ T8		
.21	680562	46L	fx T3		$\delta \rightarrow D5$
.22	680506		fx S7		
IX.23	N40524	470	f(+) D5		
.24	100524		fM D5		
.25	000565	471	f+ T6		
.26	680505		fx S6		
.27	N40524	472	f(+) D5		
.28	100524		fM D5		
.29	000563	473	f+ T4		
.30	680507		fx S8		
.31	N40524	474	f(+) D5		
.32	100524		fM D5		
X.0	000524	475	f+ D5		Unused
.1	000519		f+ S26		
.2	040520	476	f(+) D1		$H' = S.T. - \alpha^*$
.3	100560		fM T1		
.4	000560	477	f+ T1		
.5	SN0111		U* sin-cos		
.6	100560	478	fM T1		$\sin H'$
.7	000017		f+ 017		
.8	100561	479	fM T2		$\cos H'$
.9	100561		fM T2		Unused
.10	000524	47K	f+ D5		
.11	SN0111		U* sin-cos		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.12	100562	47S	fM T3		sin $\theta$
.13	000017		f+ 017		
.14	100563	47N	fM T4		Cos $\theta$
.15	100563		fM T4		Unused
.16	000517	47J	f+ S24		
.17	SN0111		• U* sin-Cos		
.18	100564	47F	fM T5		sin $\phi$
.19	000017		f+ 017		
.20	100565	47L	fM T6		Cos $\phi$
.21	100565		fM T6		Unused
X.22	000563	480	f+ T4		
.23	680561		fx T2		
.24	680565	481	fx T6		
.25	100566		fM T7		
.26	000562	482	f+ T3		
.27	680564		fx T5		
.28	FM0566	483	f(+)M T7		Cos z
X.29	F40566		f(+) T7		
.30	040586	484	f(-) C7		Test:  Cos z  > 1.0?
.31	4N04J0		fc XII.1		Go to Box XII
X.32	000566	485	f+ T7		
.33	680566		fx T7		
.34	100567	486	fM T8		
.35	000586		f+ C7		
.36	040567	487	f(-) T8		
.37	100567		fM T8		
.38	000567	488	f+ T8		
.39	SN01J2		U* $\sqrt{N}$		
.40	100567	489	fM T8		sin z
.41	780566		f $\frac{1}{2}$ T7		
.42	100568	48K	fM T9		tan z
.43	NN048N		fU XI.1		Transfer to Box XI
.44	100569	48S	fM T10		
.45	100569		fM T10		Unused
XI.1	000568	48N	f+ T9		
.2	680568		fx T9		
.3	10056K	48J	fM T11		
.4	680568		fx T9		
.5	100568	48F	fM T12		
.6	68058J		fx C14		
.7	10056N	48L	fM T13		
.8	00056K		f+ T11		
XI.9	00056K	490	f+ T11		
.10	680568		fx T12		
.11	68058F	491	fx C15		
.12	04056N		f(-) T13		
.13	10056K	492	fM T11		
.14	000568		f+ T9		
.15	68058N	493	fx C13		
.16	N4056K		f(+) T11		

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.17	10056K	494	fM T11		
.18	000508		f+ S12		
.19	68058K	495	fx C11		
.20	N40586		f(+) C7		
.21	680588	496	fx C9		
.22	100568		fM T12		
.23	000589	497	f+ C10		r → T11
.24	68058K		fx C11		
.25	N40586	498	f(+) C7		
.26	68050K		fx S11		
.27	780568	499	f÷ T12		
.28	68056K		fx T11		
.29	10056K	49K	fM T11	↓	
.30	000567		f+ T8	↑	
.31	680563	49S	fx T4		
.32	100568		fM T12		
.33	240566	49N	f÷ T7		Cos q → T12
.34	680562		fx T3		
.35	N40564	49J	f(+) T5		
.36	780568		f÷ T12		
.37	100568	49F	fM T12	×	
.38	000560		f+ T1	↑	
.39	680565	49L	fx T6		sin q → T13
.40	780567		f÷ T8		
.41	10056N	4K0	fM T13	↓	
.42	00056K		f+ T11	↑	
.43	680568	4K1	fx T12		8'
.44	FN0524		f(+)M D5		
.45	NN04NN	4K2	fU XI.55	↓	
.46	NN04NN		fU XI.55	↑	
.47	680568	4K3	fx T12		
.48	FN0524		f(+)M D5		
.49	NN04NN	4K4	fU XI.55		Unused
.50	NN04NN		fU XI.55		
.51	780567	4K5	f÷ T8		
.52	680568		fx T12		
.53	100561	4K6	fM T2		
.54	100561		fM T2	×	
XIII.1	00050N	4K7	f+ S13	↑	
.2	SN0111		U* sin-Cos		
.3	100562	4K8	fM T3		
.4	000017		f+ O17		
.5	100563	4K9	fM T4		
.6	000562		f+ T3		
.7	680561	4KK	fx T2		ξ → P1
.8	100564		fM T5		
.9	00056J	4KS	f+ T14		
.10	680563		fx T4		
.11	040564	4KN	f(•) T5		
.12	100540		fM P1	↓	

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
.13	000563		f+ T4		
.14	680561	4KJ	fx T2		
.15	100564		fM T5		
.16	00056J	4KF	f+ T14		$\eta \rightarrow P2$
.17	680562		fx T3		
.18	N40564	4KL	f(+) T5		
XIII.19	100541		fM P2		
.20	100541	4S0	fM P2		Unused
.21	0005K7		f+ W4		
.22	SN02FJ	4S1	U* IBMR		
.23	NN060K		FU I.21		
.24	NN060K	4S2	FU I.21		
.25					
.26		4S3			4S3 - 4S5 is available
	800003				
	2004S6				Key Word
IV.80	000517		f+ S14		
.81	N40517	4S6	f(+) S14		
.82	10050F		fM S15		
.83	10050F	4S7	fM S15		
.84	00050F		f+ S15		
.85	SN01L1	4S8	U* sin-Cos		
.86	000017		f+ O17		
.87	10050F	4S9	fM S15		
.88	000592		f+ C19		
.89	68050F	4SK	fx S15		$\bar{P}_a \rightarrow S11$
.90	10050F		fM S15		
.91	00050J	4SS	f+ S14		
.92	78058S		f+ C12		
.93	10050L	4SN	fM T16		
.94	FN050L		f(+)M T16		
.95	000586	4SJ	f+ C7		
.96	04050F		f(-) T15		
.97	04050L	4SF	f(-) T16		
.98	68050K		fx S11		
.99	10050K	4SL	fM S11		
.53	NN060K		FU I.21		
.54	NN060K	4NO	FU I.21		
	800003				
	2004NN				
XI.55	000524		f+ D5		
.56	SN01L1	4NN	U* sin-Cos		
.57	100562		fM T3		
.58	000017	4NJ	f+ O17		$\sin \delta'$
.59	100563		fM T4		
.60	00056K	4NF	f+ T11		$\cos \delta'$
.61	68056N		fx T13		
.62	780563	4NL	f+ T4		
.63	FN0520		f(+)M D1		
XII.1	00051K	4JO	f+ S27		$\alpha^{**} \rightarrow D1$

SEQUENCE	CODE	ADDRESS	ORDER	INDEX	DESCRIPTION
	K20K2K	5K0	B1		Format S10 - S2
	2K02K2				
	000000	5K1	B2		Format S8 - S2
	000000				
	820828	5K2	B3		
	280282				
	820000	5K3	B4		Input C1 - C26
	000000				
	05001K	5K4	W1		Input data and print identification
	100580				
	060006	5K5	W2		Unused
	100560				
	060003	5K6	W3		Print Output data
	100563				
	060006	5K7	W4		Unused
	100540				
	060006	5K8	W5		
	100511				
Option					
	800003				
	2004F2				
	000544	4F2	f+ P5		Boss number
	100543		fM P4		
	000586	4F3	f+ C7		
	N40586		f(+) C7		
	100544	4F4	fM P5		Point type
	NN04K7		fU XIII.1		
	800001				
	000111				



### 3. DATA

### 3.1 Format

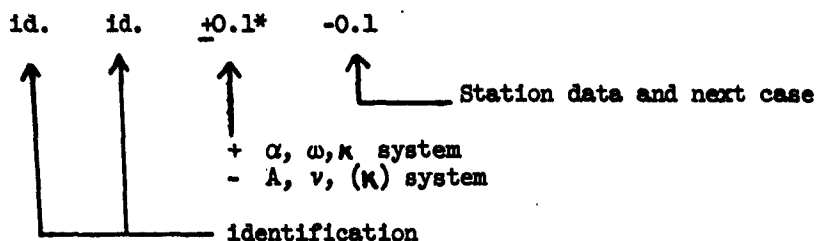
Each datum number is identified as a field for input and output purposes using standard floating decimal (S8-S2), coefficient (sign and 8 digits) with exponent (sign and 2 digits). The sign is punched in a separate column using zero or "no punch" for plus and "X" punch for minus.

### 3.2 Input

The first 10 cards of the input for the "Star Identification" and "Computation of Standard Coordinates" for Stars are identical. However, the data on cards 3 and 5 ( $\phi_0$  and S.T.<sub>0</sub>) are not used in the "Star Identification Computation". They are included in order that the first 10 cards of the input data can be used for both "Star Identification" and "Computation of Standard Coordinates". Cards 11 and 12 are additional for Star Identification only. Field 4 must be a non-zero negative number on card 1.

The first 10 cards contain the following information:

#### Card 1 (Parameter Card)



#### Card 2

Fields 1-3,  $\phi$  in degrees, minutes and seconds.

Field 4, zero

Field 5,  $\pm Z$

Field 6, immaterial

\* This signal only applies to "Star Identification" and maybe any non-zero positive or negative number.

Card 3

Fields 1-3,  $\phi_0$ , in degrees, minutes and seconds.

Fields 4-6, immaterial.

Card 4

Fields 1-3, S.T. in hours, minutes and seconds.

Fields 4-6, immaterial.

Card 5

Fields 1-3, S.T. in hours, minutes and seconds.

Fields 4-6 immaterial.

Card 6

Fields 1-3 "G" in hours, minutes and seconds.

Fields 4-6, immaterial.

Card 7

Fields 1-3, "H" in hours, minutes and seconds.

Fields 4-6, immaterial.

Card 8

Field 1 ( $f+f'$ ) in seconds of time.

Fields 2-3 "g" and "h" in seconds of arc.

Fields 4-6, immaterial.

Card 9

Field 1, "i" in seconds of arc.

Field 2, "r" (part of year).

Field 3, " $\Delta T$ " number of years since 1950 (as the information in the Boss Catalogue dates from 1950).

Card 10

Field 1, " $P_a$ " (mm) pressure at station.

Field 2, " $t_a$ " (centigrade) temperature at station.

Fields 3-5, " $\Delta$ " angle (rotation angle) in degrees, minutes and seconds.

Field 6, " $H_a$ " (meters) height of station.

Card 11

Fields 1-3,  $\alpha$ ,  $\omega$ ,  $\kappa$  in grads, or  $A$ ,  $v$ , ( $\kappa$ ) in grads.

Fields 4-6, immaterial.

Card 12

Fields 1-3, c, xp, yp (meters), respectively.

Fields 4-6, immaterial.

Star data for Computation of Standard Coordinates consists of 4 cards from Boss Catalogue as follows:

Card 1

Fields 1-3, R.A. (right ascension) in hours, minutes, and seconds.

Field 4, immaterial.

Fields 5-6, Boss number and point number.

Card 2

Field 1, Annular variation.

Field 2, Secular variation.

Field 3,  $\mu$

Field 4, immaterial.

Fields 5-6, Boss number and point number, respectively.

Card 3

Fields 1-3, Declination in degrees, minutes and seconds.

Field 4, immaterial.

Fields 5-6, Boss number and point number, respectively.

Card 4

Field 1, Annular variation.

Field 2, Secular variation.

Field 3,  $\mu'$

Field 4, immaterial.

Fields 5-6, Boss number and point number, respectively.

Point data (measurements) used for Star identification consists of one card per point as follows:

Card 1

Fields 1-2,  $l_x$ ,  $l_y$  (from comparator)

Fields 3-5, immaterial for this program. It is suggested that the Output Cards from the Stereo Comparator code be used for the Input of Star Identification and Camera Orientation.

Field 6, point number.

### 3.3 Output

1. Star Identification consists of 2 cards. Card 1 contains  $\alpha$  (hours, minutes, seconds) and card 2 contains  $\delta$  (degrees, minutes, seconds). Field 6 contains point number and fields 4-5 are immaterial.

2. Computation of Standard Coordinates consists of 1 card as follows:

$\xi, \eta, Z = \pm 1.0$ , zero, Boss No. and Point No.

3. Option prints:

$\xi, \eta, Z = \pm 1.0$ , Boss No., type, and point No.

*A. Roberta Wooten*

A. ROBERTA WOOTEN

#### 4. SAMPLES



### 4.2.1 Input:

[illegible][illegible]



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